PATENT ABSTRACTS OF JAPAN

(11)Publication number : **11-109392**

(43)Date of publication of application : **23.04.1999**

(51)Int.Cl. **G02F 1/1343**

G02F 1/1335

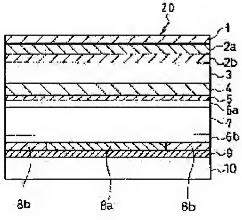
(21)Application number : **09-271812**

(22)Date of filing : **06.10.1997**

(71)Applicant : **MATSUSHITA ELECTRIC IND CO LTD**

(72)Inventor : **IWAI YOSHIO**
SEKIME TOMOAKI
YAMAGUCHI HISANORI
OGAWA TETSU

(54) REFLECTION TYPE LIQUID CRYSTAL DISPLAY ELEMENT AND REFLECTION TYPE LIQUID CRYSTAL DISPLAY PANEL



(57)Abstract:

PROBLEM TO BE SOLVED: To maintain a wide angle of a visual field and to improve reflectance, contrast and color purity by forming a scattering part and a mirror part for incident external light in a reflection electrode so as to produce distribution of directions of reflected light.

SOLUTION: A photoresist film 21 is formed on an insulating film 9 and a reflection electrode substrate 10 is exposed in an oxygen plasma to slightly etch the surface of a part where the photoresist film is not present. Then the photoresist film is removed and a titanium and aluminum film is formed on the insulating film 9. Thus, a mirror part where incident external light is wholly reflected and a white scattering part where incident external light is scattered are formed on the surface of the film after formed. Then a photoresist film is formed on the mirror part and the scattering part surrounding the mirror part, and the titanium and aluminum film is etched. Then the photoresist film is removed. Thus, a reflection electrode 8a having mirror property and a reflection electrode 8b having scattering property are

formed on each reflection type liquid crystal display element 20.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the high-reflective-liquid-crystal display device which is each pixel of the high-reflective-liquid-crystal display panel of reflective liquid crystal display, and said panel.
[0002]
[Description of the Prior Art]When the display type of a liquid crystal display is divided roughly, it has a transmission type and a reflection type. Transmissive liquid crystal display (hereafter referred to as transmission type LCD.), To making the back light as a light source emit light inside, and displaying on it, surrounding outdoor daylight passes the front face of a display panel, and enters, and reflective liquid crystal display (hereafter referred to as reflection type LCD.) is displayed by making it reflect in the direction of said panel with a light reflector.
[0003]By using surrounding outdoor daylight, reflection type LCD has the unnecessary back light used by transmission type LCD, and reduction of power consumption is possible for it. For this reason, reflection type LCD is the optimal as a display used for a portable information terminal or a portable equipment.
[0004]However, reflective LCD which displays by reflecting the outdoor daylight which entered does not have the function to adjust incident light. For this reason, when the illumination of outdoor daylight is weak, since there is little entering outdoor daylight, by the case where it is used in indoor or the night, there is a fault which a display screen becomes very dark and in which visibility deteriorates, for example.
[0005]For this reason, in reflection type LCD, it is necessary to raise reflectance so that the outdoor daylight which entered may be reflected efficiently. As a means which raises reflectance, reducing the propagation loss of the light in a liquid crystal cell or an optical member and carrying out total internal reflection of the incident light with a light reflector are mentioned.
[0006]As a method which reduces the propagation loss of the light by the liquid crystal cell or an optical member, Paying attention to the transmission loss of the light in a polarizing plate being the largest, the one-sheet polarizing plate method (patent publication before examination: common [7-84252]) etc. which made one sheet the guest host type display type (patent publication before examination: common [7-146469]) who does not use a polarizing plate, and the polarizing plate are known.
[0007]In a guest host method, since a polarizing plate is not used, reflectance can be enlarged, but a contrast ratio is low in order to display by 2 color ratio of coloring matter theoretically. A multi-gradation display is [that it is easy to generate a hysteresis with the orientation method of a liquid crystal] difficult.
[0008]In an one-sheet polarizing plate method, since the entering outdoor daylight passes a polarizing plate twice, although reflectance is low, compared with a guest host method, high contrast is realizable. It is considered as the method of carrying out total internal reflection of the incident light, and the method (patent publication before examination: common [8-101384]) using aluminum of mirror plane nature with high reflectance as a

light reflector and electrode (it is hereafter called a reflector.) is known.
[0009]However, the directivity of light becomes strong while reflectance becomes high, when the reflector of mirror plane nature is used. For this reason, in a total internal reflection point, reflection luminance becomes extremely high, a feeling of GIRAGIRA and metallic feeling by reflected of outdoor daylight occur, from the other viewpoint, reflection luminance becomes extremely low and there is a fault in which visibility gets worse.
[0010]For this reason, while controlling the directivity of catoptric light, in order to expand an angle of visibility, the method (patent publication before examination: common [8-201802]) which newly provides a diffusion sheet in the exterior of a substrate, and the method (patent publication before examination: common [8-338993]) which makes a reflector a diffusion type are known.
[0011]The high-reflective-liquid-crystal display panel of the conventional reflection type LCD comprises the polarizing plate 31, the high polymer film 32, the glass substrate 33, the light filter 34, the transparent electrode 35, the liquid crystal 36, the reflector 37, and the glass substrate 38, as shown in drawing 15.
[0012]This high-reflective-liquid-crystal display panel uses together the one-sheet polarizing plate method which made the polarizing plate one sheet, and the method which makes a reflector a diffusion type, and it expands an angle of visibility while it reduces the propagation loss of light and controls the directivity of catoptric light.
[0013]All the surfaces of the reflector 37 form detailed unevenness, and are performing the surface treatment so that it may have dispersion nature.
[0014]
[Problem(s) to be Solved by the Invention]Since the direction of light which carries out reflective dispersion is not specified, the reflector 37 which has dispersion nature is reflected in all the directions.
[0015]Usually, when light enters into a low medium from a medium with a high refractive index, total internal reflection happens depending on the entering angle. A total reflection angle can be searched for from the refractive index of said two media using the formula of Snell.
[0016]Since the refractive index of the transparent electrode 35 in which the refractive index of glass consists of 1.5 and oxidation yne JUUMU tin (hereafter referred to as ITO.) is 1.9, a total reflection angle is about 52 degrees from the formula of Snell.
[0017]As shown in drawing 16 (a), when the incidence angle theta 1 is 52 degrees or less, emit the light which reflected with the reflector 37 which has dispersion nature, and passed the transparent electrode 35, but. As shown in drawing 16 (b), when the incidence angle theta 1 is 52 degrees, it progresses along the surface, and as shown in drawing 16 (c), when the incidence angle theta 1 is not less than 52 degrees, total internal reflection is carried out, without being emitted.
[0018]If the light which reflected with the reflector 37 which has dispersion nature, and passed the transparent electrode 35 enters into the glass substrate 33 at the angle of about 52 degrees or less to the normal of the glass substrate 33, total internal reflection will happen and this catoptric light will not be emitted out of a liquid crystal cell.
[0019]When catoptric light was scattered about, the angle of visibility was expanded, and directivity was controlled, but reflectance falls by the catoptric light which carries out total internal reflection and is not emitted, and there is a problem to which a screen

becomes dark. The depolarization of catoptric light occurs with detailed unevenness of the surface of the reflector 37 which has dispersion nature, and there is a problem which carries out a contrast drop compared with the reflector which has mirror plane nature. There is a problem to which mixed colors occur and color purity falls.

[0020]An object of this invention is to provide the high-reflective-liquid-crystal display device reflectance, contrast, and whose color purity improved while maintaining expansion of the angle of visibility.

[0021]

[Means for Solving the Problem]A high-reflective-liquid-crystal display device of this invention is a high-reflective-liquid-crystal display device which is each pixel which displays by reflecting outdoor daylight which passed a liquid crystal layer and entered from a counter substrate in the direction of said counter substrate with a reflector board which provided a reflector, A portion which has dispersion nature to outdoor daylight which entered, and a portion which has mirror plane nature were provided in a reflector, and direction distribution of catoptric light was formed in it.

[0022]According to this invention, while maintaining expansion of an angle of visibility, a high-reflective-liquid-crystal display device reflectance, contrast, and whose color purity improved can be obtained.

[0023]

[Embodiment of the Invention]The invention of this invention according to claim 1 is a high-reflective-liquid-crystal display device which is each pixel which displays by reflecting the outdoor daylight which passed the liquid crystal layer and entered from the counter substrate in the direction of said counter substrate with the reflector board which provided the reflector, In a reflector, it is considered as the high-reflective-liquid-crystal display device which provided the portion which has dispersion nature to the outdoor daylight which entered, and the portion which has mirror plane nature, and formed the direction distribution of catoptric light, and while maintaining expansion of an angle of visibility, reflectance, contrast, and color purity can be improved.

[0024]The invention of this invention according to claim 2 can be used as the high-reflective-liquid-crystal display device according to claim 1 which enlarged the area of the portion which has mirror plane nature compared with the area of the portion which has dispersion nature, and can strengthen a regular reflection component.

[0025]The invention of this invention according to claim 3 is taken as the high-reflective-liquid-crystal display device according to claim 2 which the ratio of the area of the portion which has mirror plane nature, and the area of the portion which has dispersion nature made 8:2 or less [6:4 or more].

[0026]The invention of this invention according to claim 4 considers it as the high-reflective-liquid-crystal display device according to any one of claims 1 to 3 which has sandwiched and arranged the portion which has mirror plane nature in the portion which has dispersion nature, and it can improve reflectance, contrast, and color purity while it maintains expansion of an angle of visibility.

[0027]The invention of this invention according to claim 5 considers it as the high-reflective-liquid-crystal display device according to any one of claims 1 to 3 which has arranged the portion which has dispersion nature around the portion which has mirror plane nature, and it can improve reflectance, contrast, and color purity while it maintains expansion of an angle of visibility.

[0028]The invention of this invention according to claim 6 in the portion which has the mirror plane nature of a reflector, and the portion which has dispersion nature. The degree of dispersion of a reflector is changeable by considering it as the high-reflective-liquid-crystal display device according to any one of claims 1 to 5, wherein surface roughness differs, and changing surface roughness.
[0029]The invention of this invention according to claim 7 is a high-reflective-liquid-crystal display device which is each pixel which displays by reflecting the outdoor daylight which passed the liquid crystal layer and entered from the counter substrate in the direction of said counter substrate with the reflector board which provided the reflector, In a reflector, it is considered as the high-reflective-liquid-crystal display device which established the flat part and the crevice in the portion which has mirror plane nature to the outdoor daylight which entered, and formed the direction distribution of catoptric light, and while maintaining expansion of an angle of visibility, reflectance, contrast, and color purity can be improved.
[0030]The invention of this invention according to claim 8 is taken as the high-reflective-liquid-crystal display device according to claim 7 which provided two or more crevices. The invention of this invention according to claim 9 can be used as the high-reflective-liquid-crystal display device according to claim 7 or 8 which enlarged the area of the flat part compared with the area of a crevice, and can strengthen a regular reflection component.
[0031]The invention of this invention according to claim 10 can be used as the high-reflective-liquid-crystal display device according to any one of claims 7 to 9 which has an inclined plane or a curved surface, can scatter catoptric light over the field to which the bottom of a flat part and a crevice is connected according to the inclined plane or curved surface of a crevice, and can expand an angle of visibility.
[0032]The angle of gradient of the inclined plane of the crevice where the invention of this invention according to claim 11 was formed in the reflector is used as the high-reflective-liquid-crystal display device according to claim 10 made into 30 degrees or less 10 degrees or more to the reflector substrates face, The light reflected in the inclined plane of the crevice can be made to emit out of a liquid crystal cell, without being scattered about and carrying out total internal reflection in respect of a counter substrate.
[0033]The invention of this invention according to claim 12 is the high-reflective-liquid-crystal display panel which allocated the pixel of a large number which display by reflecting the outdoor daylight which passed the liquid crystal layer and entered from the counter substrate in the direction of said counter substrate with the reflector board which provided the reflector, It is considered as the high-reflective-liquid-crystal display panel which provided the portion which has dispersion nature in a reflector to the outdoor daylight which entered for every aforementioned pixel, and the portion which has mirror plane nature in the position for every pixel of a reflector, By having provided the portion which has dispersion nature to the outdoor daylight which entered, and the portion which has mirror plane nature, and having formed the direction distribution of catoptric light, while maintaining expansion of an angle of visibility, reflectance, contrast, and color purity can be improved, and the high-reflective-liquid-crystal display panel whose display quality improved can be obtained.
[0034]Hereafter, the high-reflective-liquid-crystal display device of this invention is explained based on a concrete embodiment.

(Embodiment 1) In the high-reflective-liquid-crystal display panel filled up with the liquid crystal between the counter substrate and the reflector board. As shown in drawing 2, the high-reflective-liquid-crystal display device 20 is formed as each pixel, and it is displaying by reflecting the outdoor daylight which passed the liquid crystal layer and entered from said counter substrate in the direction of a counter substrate with the reflector board which provided said reflector.

[0035]When this one high-reflective-liquid-crystal display device 20 is illustrated, it comes to be shown in drawing 1. According to the manufacturing process of this high-reflective-liquid-crystal display panel, it explains concretely. The light filter 4 of the red who consists of pigment dispersion resist on this counter substrate 3, and green and blue stripe shape is formed in the counter substrate 3 shown in drawing 1 for every pixel using alkali soda glass.

[0036]Then, on the light filter 4, the ITO film was formed and the transparent electrode 5 of stripe shape was formed by the photolithography. Next, the insulator layer 9 which consists of polymer was formed on the reflector board 10 using alkali soda glass. Using a heat-hardened type acrylic resin (for example, FOC: product made from FUJIYAKUHIN Industry) as polymer, it applied with the spin coat and heat-treated at 200 **.

[0037]Next, using the photolithography, as shown in drawing 3 (a), the photoresist film 21 was formed on the insulator layer 9. The area ratio of the portion of the photoresist film 21 and the portion 22 without a photoresist film was set to 7:3.

[0038]Then, the reflector board 10 was exposed for 2 minutes into oxygen plasma using the reactive ion etching system, and the surface of the portion 22 without a photoresist film was etched slightly.

[0039]Next, after removing the photoresist film 21, titanium and aluminum were formed by thickness (about 80 nm and about 200 nm) on the insulator layer 9, respectively. Observation of the surface after membrane formation checked that the mirror plane portion 8c in which the outdoor daylight which entered is reflected as it is, and 8 d of dispersion portions which the outdoor daylight which entered is scattered and are reflected and which became cloudy were formed, as shown in drawing 3 (b).

[0040]When the electron microscope compared the surface state in the mirror plane portion 8c and 8 d of dispersion portions, the difference was looked at by the surface state, it originated in the surface state of the insulator layer 9 which is a ground, and the particle diameter of aluminum was large clearly in 8d of dispersion portions.

[0041]The rough condition of the surface which formed membranes has the dependency of oxygen plasma treatment, and dispersion nature will become large if oxygen plasma treatment is strengthened. Then, titanium and aluminum are etched after forming the photoresist film 21 in the mirror plane portion 8c and 8 d of dispersion portions of the circumference, as shown in drawing 3 (c) using a photolithography.

[0042]By removing the photoresist film 21, as shown in drawing 3 (d), the reflector 8a which has mirror plane nature every high-reflective-liquid-crystal display device 20, and the reflector 8b which has dispersion nature were formed, respectively.

[0043]On the transparent electrode 5 and the reflector 8a which are shown in drawing 1, and 8b, the polyamic acid solution of 5 % of the weight of solids concentration. After printing (for example, SE-150:Nissan Chemical Industries, Ltd. make) and hardening at 220 **, rotation rubbing was carried out using the rayon cloth, orientation treatment was performed so that a twist angle might be 250 degrees, and the orienting films 6a and 6b

which consist of polyimide were formed.
[0044]Next, establish a liquid crystal inlet in the periphery of the counter substrate 3, and print formation of the heat-hardened type sealant (for example, a SUTORAKUTO bond: made by Mitsui Toatsu Chemicals, Inc.) is carried out to it, On the reflector board 10, the spherical spacer which consists of a plastic 6 micrometers in diameter was 150-200 piece [/mm]--^{2}-distributed, the counter substrate 3 and the reflector board 10 of each other were pasted together, and the sealant was hardened at 150 **.
[0045]Next, refractive index anisotropy carried out vacuum pouring of the liquid crystal 7 which added the chiral constituent (for example, S-811: Merck Japan, Inc.) to the ester system nematic liquid crystal composition which is 0.13, obturated the inlet with ultraviolet curing resin, and produced the liquid crystal cell.
[0046]The high polymer film 2a and the polycarbonate film which has the birefringence of a predetermined size as 2b are stuck on the counter substrate of the liquid crystal cell formed by the above at an angle of predetermined, The polarization film of neutral gray was stuck so that an absorption axis might become in the predetermined direction, and the high-reflective-liquid-crystal display panel was produced.
[0047]Next, voltage was impressed by 1/240 of simple matrix driving, and the reflectance characteristics of the transverse plane of reflection type LCD using a high-reflective-liquid-crystal display panel were measured. The reflectance characteristics over impressed electromotive force entered incident light at the angle of 10 degrees to the perpendicular direction using the LCD evaluation system (LCD-7000: made by Otsuka Electronics Co., Ltd.), and the electric eye was measured under the conditions installed in 0 degree (perpendicular direction).
[0048]As the measurement result of the reflectance characteristics over impressed electromotive force was shown in drawing 4, in Y value conversion, transverse-plane reflectance was 14.7% in 2% and ON voltage on OFF voltage, and was contrast 7.3. In intermediate color voltage, it changed from black to white through gray, and the colorless change without coloring was obtained.
[0049]Next, it measured about the visual angle dependency of reflection type LCD. As shown in drawing 5, visual angle dependency measurement irradiates reflection type LCD from the light source 18 provided in the upper position of reflection type LCD, and receives catoptric light by the electric eye 19.
[0050]Incident light was first entered from the angle of -5 degrees to the perpendicular direction of reflection type LCD, and the position theta of the electric eye was changed to 0 degree - +50 degrees. Next, incident light was entered from the angle of +5 degrees, and the electric eye was changed to 0 degree--50 degree.
[0051]the case of ON voltage, and in the case of OFF voltage, it was alike, it attached, and measured, respectively. As the visual angle dependency measurement result in ON voltage is shown in drawing 6, it turns out that the characteristic of reflection type LCD of this invention is bright [reflectance is high in -15 to +25 degrees, and / reflection type LCD of a conventional example] compared with the characteristic of reflection type LCD of a conventional example.
[0052]About visual angle dependency when the OFF voltage of reflection type LCD of this invention was impressed, the result with low reflectance was obtained compared with the former. This is considered to be because for the depolarization in the dispersion nature electrode to have been reduced.

[0053]Therefore, in reflection type LCD of this invention, it has checked that contrast was improving. When the fluorescent lamp was made to turn on from the upper surface and visibility was evaluated, a feeling of GIRAGIRA and a metallic feeling as which the whole surface is regarded in the reflector which has mirror plane nature were reduced, and good display properties were acquired.
[0054]Next, the surface ratio of the area S1 of the reflector which has mirror plane nature, and the area S2 of the reflector which has dispersion nature was changed, respectively, reflection type LCD was produced by the same method, and reflectance and the visual angle characteristic of contrast were compared. As a result, when there was S1:S2 in the or more 6:4 8:2 or less range, reflectance and contrast are highly suitable and it turned out that a metallic feeling can be reduced. S1: It turned out that the ratio of S2 cannot cancel a metallic feeling or more by 9:1, and reflectance and contrast fall or less by 5:5, and the characteristic gets worse.
[0055]It is not considered as the portion which has dispersion nature by the above thing to the outdoor daylight which entered all the surfaces of the reflector like before, Provide the portion which has dispersion nature, and the portion which has mirror plane nature in a reflector for every pixel, form the direction distribution of catoptric light, and the outdoor daylight which entered, Since the light by which regular reflection was carried out in the portion of the reflector 8a which has mirror plane nature is altogether emitted out of a liquid crystal cell, It is emitted in the dispersion direction, the degree of emitting angle becomes large, and the light by which scatter reflection was carried out in the portion of the reflector 8b which reflectance can be high, can improve contrast and has dispersion nature can maintain expansion of an angle of visibility.
[0056]The high-reflective-liquid-crystal display panel whose display quality improved can be obtained by allocating two or more these high-reflective-liquid-crystal display devices. (Embodiment 2) In the high-reflective-liquid-crystal display panel filled up with the liquid crystal between the counter substrate and the reflector board. As shown in drawing 8, the high-reflective-liquid-crystal display device 20 is formed as each pixel, and it is displaying by reflecting the outdoor daylight which passed the liquid crystal layer and entered from said counter substrate in the direction of a counter substrate with the reflector board which provided said reflector.
[0057]This one high-reflective-liquid-crystal display device 20 is a pixel of the high-reflective-liquid-crystal display panel in which the thin film transistor element (hereafter referred to as TFT.) 13 was formed on the reflector board 10, as shown in drawing 7.
[0058]The point of difference with Embodiment 1 is a point which is a active-matrix type which has a switching element on the reflector board 10. According to the manufacturing process of this high-reflective-liquid-crystal display panel, it explains concretely.
[0059]The light filter 4 was formed in the counter substrate 3 shown in drawing 7 using the method as Embodiment 1 that it is the same on this counter substrate 3, using alkali free glass (for example, 1737: made by Corning, Inc.), and the transparent electrode 5 which consists of ITO(s) was further formed in the whole surface.
[0060]By next, the method predetermined to the reflector board 10 top using alkali free glass. The gate electrode 11 which consists of aluminum and tantalum, the source electrode 12 which consists of titanium and aluminum, and the drain electrode 14 have been arranged to matrix form, and TFT element 13 which becomes each intersection of the gate electrode 11 and the source electrode 12 from an amorphous silicon was formed.

[0061]After applying the photosensitive acrylic resin (for example, FVR: product made from FUJIYAKUHIN Industry) of the positive type all over the reflector board 10 and forming the flattening film 15, UV irradiation was carried out using the predetermined photo mask, and the contact hole 16 was formed on the drain electrode 14.
[0062]Then, positive type photoresist was applied on the flattening film 15, and it exposed using the photo mask of a long direction lattice-like transmission pattern, and as shown in drawing 9 (a), the resist film 21 was formed. The area ratio of the portion which formed the resist film 21, and the portion which has not formed the resist film 21 was set to 7:3.
[0063]Then, the reflector board 10 was exposed for 2 minutes into oxygen plasma using the reactive ion etching system, and the surface of the portion in which the photoresist film 21 of the flattening film 15 is not formed was etched slightly.
[0064]Next, after removing the photoresist film 21, titanium and aluminum were formed by thickness (about 80 nm and about 200 nm) on the flattening film 15, respectively. Observation of the surface after membrane formation checked that the mirror plane portion 8c in which the outdoor daylight which entered is reflected as it is, and 8 d of dispersion portions which the outdoor daylight which entered is scattered and are reflected were formed, as shown in drawing 9 (b).
[0065]Then, titanium and aluminum are etched after forming the photoresist film 21 in the mirror plane portion 8c and 8 d of dispersion portions of the circumference, as shown in drawing 9 (c) using a photolithography.
[0066]By removing the photoresist film 21, as shown in drawing 9 (d), the reflector 8a which has mirror plane nature every high-reflective-liquid-crystal display device 20, and the reflector 8b which has dispersion nature were formed, respectively.
[0067]On the transparent electrode 5 and the reflector 8a which are shown in drawing 7, and 8b, the polyamic acid solution (SE-7211: Nissan Chemical Industries, Ltd.) of 5 % of the weight of solids concentration is printed, After hardening at 220 **, rotation rubbing was carried out using the rayon cloth, orientation treatment was performed so that it might become homogeneous orientation, and the orienting films 6a and 6b which consist of polyimide were formed.
[0068]Next, establish a liquid crystal inlet in the periphery of the counter substrate 3, and print formation of the heat-hardened type sealant (for example, a SUTORAKUTO bond: made by Mitsui Toatsu Chemicals, Inc.) is carried out to it, On the reflector board 10, the spherical spacer which consists of a plastic 4.5 micrometers in diameter was 150-200 piece [/mm]$^{-2}$-distributed, the counter substrate 3 and the reflector board 10 of each other were pasted together, and the sealant was hardened at 150 **.
[0069]Next, refractive index anisotropy carried out vacuum pouring of the liquid crystal 7 which added the chiral constituent to the fluorine system nematic liquid crystal composition which is 0.097, obturated the inlet with ultraviolet curing resin, and produced the liquid crystal cell.
[0070]The high polymer film 2a and the polycarbonate film which has the birefringence of a predetermined size as 2b are stuck on the counter substrate 3 of the liquid crystal cell formed by the above at an angle of predetermined, The polarization film 1 of neutral gray was stuck so that an absorption axis might become in the predetermined direction, and the high-reflective-liquid-crystal display panel of the active matrix type was produced.
[0071]When reflection type LCD using this high-reflective-liquid-crystal display panel

was driven and the reflectance in the transverse plane was measured, reflectance is [reflectance] 16.3% in 1.5% and a white state in the state of black, and the colorless good reflection property has been realized.
[0072]When viewing-angle dependence of lateral reflectance was evaluated, the reflectance of the white level was obtained not less than 10% in -20 degree to +25 degrees, and the reflectance of the black level was 2% or less in the same range, and was 5.0 or more about contrast in this range.
[0073]It has checked that it was reflected according to the angle of gradient of said inclined plane, and the outdoor daylight which entered into the inclined plane of the contact hole 16 expanded an angle of visibility. When visibility was checked, compared with the case where a whole surface reflector is used, the metallic feeling was reduced and it has checked having also expanded the angle of visibility.
[0074]Like Embodiment 1, the relation between the area S1 of the reflector 8a for which it has mirror plane nature, and the area S2 of the reflector 8b which has dispersion nature filled S1>S2, and 8:2 or less [6:4 or more] were [S1:S2] the most desirable.
[0075]It is not considered as the portion which has dispersion nature by the above thing to the outdoor daylight which entered all the surfaces of the reflector like before, Provide the portion which has dispersion nature, and the portion which has mirror plane nature in a reflector for every pixel, form the direction distribution of catoptric light, and the outdoor daylight which entered, Since the light by which regular reflection was carried out in the portion of the reflector 8a which has mirror plane nature is altogether emitted out of a liquid crystal cell, It is emitted in the dispersion direction, the degree of emitting angle becomes large, and the light in which reflectance was reflected in the portion of the reflector 8b which can be expensive, can improve contrast and has dispersion nature can maintain expansion of an angle of visibility.
[0076]It is reflected according to the angle of gradient of said inclined plane, and the outdoor daylight which entered into the inclined plane of the contact hole 16 can expand an angle of visibility. Although the portion which has dispersion nature around the portion which has mirror plane nature has been arranged in Embodiment 1 and Embodiment 2, even if it is a case where only the right and left of a portion or the upper and lower sides which has mirror plane nature has been inserted and arranged in the portion which has dispersion nature, the almost same effect can be acquired.
[0077]In Embodiment 1 and Embodiment 2, although the acrylic resin was used for the insulator layer, the effect that thermally stable polymers, such as polyimide, are also the same is acquired.
(Embodiment 3) In the high-reflective-liquid-crystal display panel filled up with the liquid crystal between the counter substrate and the reflector board. As shown in drawing 11, the high-reflective-liquid-crystal display device 20 is formed as each pixel, and it is displaying by reflecting the outdoor daylight which passed the liquid crystal layer and entered from said counter substrate in the direction of a counter substrate with the reflector board which provided said reflector.
[0078]When this one high-reflective-liquid-crystal display device 20 is illustrated, it comes to be shown in drawing 10. According to the manufacturing process of this high-reflective-liquid-crystal display panel, it explains concretely. The insulating layer 9 shown in drawing 10 was formed in 3-micrometer thickness using the photosensitive acrylic resin having heat melt nature and thermosetting.

[0079]After it carried out UV irradiation using the photo mask which has a circular pattern of the diameter of 10 micrometer after that and organic alkali solution performed two steps of heat treatments through development, the two holes 17 were formed regularly.
[0080]The 1st step of heat treatment was neglected for 5 minutes on the hot plate, and the 2nd step of heat treatment was performed at 200 ** for 1 hour using oven. The 1st step of heat treatment temperature was gradually changed from 140 ** to 200 **. The inclination of the hole became gently-sloping, so that the 1st step of heat treatment temperature was set as the elevated temperature.
[0081]Next, after forming titanium and aluminum by thickness (about 80 nm and about 200 nm) on the insulator layer 9, respectively, the flattening film 15 was etched in the shape of a lattice type, and the reflector 8a which has the mirror plane nature corresponding to the high-reflective-liquid-crystal display device 20 was formed.
[0082]The hole 17 formed in the reflector 8a which has mirror plane nature comprises the inclined plane 17a and the bottom 17b, as shown in drawing 12. Although the incident light from the upper part carries out regular reflection and is reflected right above in the bottom 17b and the flat part 17c, according to the angle of gradient psi, the optical path of catoptric light changes in the inclined plane 17a.
[0083]In the inclined plane 17a, since it reflects according to the angle of gradient psi, it can consider that it has dispersion nature to regular reflection, and the rate of scatter reflection changes according to the number and the angle of gradient psi of a hole.
[0084]The same processing as Embodiment 1 was performed for the reflector board 10 and the counter substrate 3 which have the hole 17, and the high-reflective-liquid-crystal display panel was produced. When reflection type LCD using this high-reflective-liquid-crystal display panel was driven and the visual angle dependency of reflectance was evaluated, like Embodiment 1, there were few reflectance falls and contrast drops in -15 to +15 degrees, and the good display by which the metallic feeling was reduced was able to be obtained.
[0085]Although the rate of scatter reflection changes with the number and the angle of gradient psi of the hole 17, The area of the flat part in a high-reflective-liquid-crystal display device which carries out specular reflexion was understood that there is [which has few losses by the total internal reflection in a counter substrate side] little decline in reflectance, when area of S3 and the crevice which carries out scatter reflection was made into S4 and it was S3>S4.
[0086]When there was the angle of gradient psi of the inclined plane 17a of a crevice at not less than 10 degrees 30 degrees or less to the field of the reflector board 10, there was little decline in reflectance and it turned out that a metallic feeling can also be reduced.
[0087]It is not considered as the portion which has dispersion nature by the above thing to the outdoor daylight which entered all the surfaces of the reflector like before,Establish a crevice in the portion which has the mirror plane nature for every pixel, form the direction distribution of catoptric light, and the outdoor daylight which entered, Since the light by which regular reflection was carried out in the portion of the flat part 17c of the reflector 8a or the bottom 17b of a crevice which has mirror plane nature is altogether emitted out of a liquid crystal cell, It is emitted according to the angle of gradient psi, the degree of emitting angle becomes large, and the light in which reflectance could be high, could improve contrast and was reflected in the inclined plane 17a of the crevice can

maintain expansion of an angle of visibility.
[0088]By having enlarged the area of the flat part which carries out specular reflexion compared with the area of the crevice which carries out scatter reflection, there are few losses by the total internal reflection in the 3rd page of a counter substrate, and they can lessen decline in reflectance.
[0089]If there is an angle of gradient of the inclined plane of a crevice at not less than 10 degrees 30 degrees or less to the field of a reflector board, there is little decline in reflectance and a metallic feeling can also reduce it.
(Embodiment 4) The high-reflective-liquid-crystal display device 20 in Embodiment 4 is a pixel of the high-reflective-liquid-crystal display panel which established the crevice 16, for example, a contact hole, and the hole 17 in the flattening film 15 on the reflector board 10, as shown in drawing 13.
[0090]Two or more high-reflective-liquid-crystal display devices 20 are allocated by the high-reflective-liquid-crystal display panel as each pixel, as shown in drawing 14. According to the manufacturing process of this high-reflective-liquid-crystal display panel, it explains concretely.
[0091]The flattening film 15 shown in drawing 13 was formed in 3-micrometer thickness using the photosensitive acrylic resin having heat melt nature and thermosetting. After it carried out UV irradiation using the photo mask which has a circular pattern of the diameter of 10 micrometer after that and organic alkali solution performed two steps of heat treatments through development, the hole 17 and the contact hole 16 on the drain electrode 14 were formed regularly.
[0092]The 1st step of heat treatment was neglected for 5 minutes on the hot plate, and the 2nd step of heat treatment was performed at 200 ** for 1 hour using oven. It is under 150 ** about the 1st step of heat treatment temperature. Melt nature became high and became a gently-sloping inclination, so that the sectional shape of the hole 17 could be controlled and it became an elevated temperature with the 1st step of heat treatment temperature.
[0093]Next, after forming titanium and aluminum by thickness (about 80 nm and about 200 nm) on the flattening film 15, respectively, the flattening film 15 was etched in the shape of a lattice type, and the reflector 8a which has the mirror plane nature corresponding to the high-reflective-liquid-crystal display device 20 was formed.
[0094]Although regular reflection of the incident light from the upper part is carried out and it is reflected right above on the bottom of the hole 17 and the contact hole 16, In the portion of the inclined plane of the hole 17 and the contact hole 16, in order that the optical path of catoptric light may change according to an angle of gradient, it can consider that it has dispersion nature to regular reflection, and the rate of scatter reflection changes according to the number of the hole 17 and the contact holes 16, and an angle of gradient.
[0095]Using the reflector board 10 and the counter substrate 3 which have the hole 17 and the contact hole 16, the same processing as Embodiment 2 was performed, and the high-reflective-liquid-crystal display panel of the active matrix type was produced.
[0096]When reflection type LCD using this high-reflective-liquid-crystal display panel was driven and the visual angle dependency of reflectance was evaluated, in the lateral viewing angle, there were few decline in reflectance and falls of contrast in -15 to +20 degrees, and the good display by which the metallic feeling was reduced was able to be obtained.

[0097]The area of the flat part which can change reflectance with the number and angle of gradient of a crevice, and carries out specular reflexion was understood that there is [which has few losses by the total internal reflection in the field of the counter substrate 3] little decline in reflectance, when area of the inclined plane of S5 and the crevice which carries out scatter reflection was set to S6 and it was S5>S6.
[0098]When there was an angle of gradient of a hole part at not less than 10 degrees 30 degrees or less to a substrates face, there was little decline in reflectance and it turned out that a metallic feeling can also be reduced. It is not considered as the portion which has dispersion nature by the above thing to the outdoor daylight which entered all the surfaces of the reflector like before, Establish a crevice in the portion which has the mirror plane nature for every pixel, form the direction distribution of catoptric light, and the outdoor daylight which entered, Since the light by which regular reflection was carried out in the portion of the flat part 17c of the reflector 8a or the bottom 17b of a crevice which has mirror plane nature is altogether emitted out of a liquid crystal cell, It is emitted according to the angle of gradient psi, the degree of emitting angle becomes large, and the light in which reflectance could be high, could improve contrast and was reflected in the inclined plane 17a of the crevice can maintain expansion of an angle of visibility.
[0099]By enlarging the area of the flat part which carries out specular reflexion compared with the area of the crevice which carries out scatter reflection, there are few losses by the total internal reflection in the field of the counter substrate 3, and they can lessen decline in reflectance.
[0100]If there is an angle of gradient of the inclined plane of a crevice at not less than 10 degrees 30 degrees or less to a substrates face, there is little decline in reflectance and a metallic feeling can also reduce it. In Embodiment 3 and Embodiment 4, although the inclined plane of the crevice was used, even if it is a case where a curved surface etc. are used, the same effect is acquired.
[0101]In Embodiment 3 and Embodiment 4, although it was considered as the two number of crevices, even if it is a case where it is considered as the singular number or plurality, the same effect is acquired. Although the light-sensitive acrylic resin which has heat melt nature and thermosetting in formation of a hole was used in Embodiment 3 and Embodiment 4, the same effect is acquired even if it uses other material and other techniques of the ability to control hole shape and area.
[0102]Although it was considered as the double reflex mode which used one polarizing plate in each embodiment, the same effect can be acquired even if it is other modes. In each embodiment, although titanium and aluminum were used as a component of a reflector, even if it uses metal, such as silver with higher reflectance, the same effect is acquired.
[0103]Although a diffusion sheet with the strong forward scattering characteristic was not provided in the exterior of the deflection film of a high-reflective-liquid-crystal display panel in each embodiment, the same effect can be acquired even if it is a case where said diffusion sheet is provided.
[0104]
[Effect of the Invention]It is not considered only as the portion which has the portion or mirror plane nature which has dispersion nature to the outdoor daylight which entered all the surfaces of the reflector like before as mentioned above according to the high-

reflective-liquid-crystal display device of this invention, The portion which has dispersion nature, and the portion which has mirror plane nature can be provided in the reflector for every pixel, the direction distribution of catoptric light can be formed, while maintaining expansion of an angle of visibility, reflectance and contrast can be made high, and color purity can be improved.

[0105]In visibility, since scatter reflection is appropriately carried out in the portion which has this dispersion nature by having provided in the reflector the portion which has dispersion nature appropriately to the portion which has mirror plane nature for every pixel, a feeling of GIRAGIRA and a metallic feeling are reduced and can acquire good display properties.

[0106]The high-reflective-liquid-crystal display panel whose display quality improved can be obtained by allocating two or more these high-reflective-liquid-crystal display devices. if the ratio of the area of the reflector which arranges the reflector which specifically has dispersion nature around the reflector which has mirror plane nature, and has mirror plane nature, and the area of the reflector which has dispersion nature is or more 6:4 8:2 or less range, reflectance and contrast will be highly suitable and a metallic feeling will be reduced -- things can be carried out.

[0107]Even if it is a case where established the flat part and the crevice in the reflector which has mirror plane nature, and the direction distribution of catoptric light is formed, while maintaining expansion of an angle of visibility, the high-reflective-liquid-crystal display device reflectance, contrast, and whose color purity improved can be obtained similarly.

[0108]By enlarging the area of the flat part which specifically carries out specular reflexion compared with the area of the crevice which carries out scatter reflection, there are few losses by the total internal reflection in the field of the counter substrate 3, and they can lessen decline in reflectance.

[0109]If there is an angle of gradient of the inclined plane of a crevice at not less than 10 degrees 30 degrees or less to a substrates face, there is little decline in reflectance and a metallic feeling can also reduce it.

[Translation done.]

CLAIMS

[Claim(s)]

[Claim 1]It is a high-reflective-liquid-crystal display device which is each pixel which displays by reflecting outdoor daylight which passed a liquid crystal layer and entered from a counter substrate in the direction of said counter substrate with a reflector board which provided a reflector, A high-reflective-liquid-crystal display device which provided a portion which has dispersion nature in a reflector to outdoor daylight which entered, and a portion which has mirror plane nature, and formed direction distribution of catoptric light.

[Claim 2]The high-reflective-liquid-crystal display device according to claim 1 which enlarged the area of a portion which has mirror plane nature compared with area of a portion which has dispersion nature.

[Claim 3]The high-reflective-liquid-crystal display device according to claim 2 which a ratio of area of a portion which has mirror plane nature, and area of a portion which has dispersion nature made 8:2 or less [6:4 or more].
[Claim 4]The high-reflective-liquid-crystal display device according to any one of claims 1 to 3 which has sandwiched and arranged a portion which has mirror plane nature in a portion which has dispersion nature.
[Claim 5]The high-reflective-liquid-crystal display device according to any one of claims 1 to 3 which has arranged a portion which has dispersion nature around a portion which has mirror plane nature.
[Claim 6]The high-reflective-liquid-crystal display device according to any one of claims 1 to 5 characterized by surface roughness differing in a portion which has the mirror plane nature of a reflector, and a portion which has dispersion nature.
[Claim 7]It is a high-reflective-liquid-crystal display device which is each pixel which displays by reflecting outdoor daylight which passed a liquid crystal layer and entered from a counter substrate in the direction of said counter substrate with a reflector board which provided a reflector, A high-reflective-liquid-crystal display device which established a flat part and a crevice in a portion which has mirror plane nature in a reflector to outdoor daylight which entered, and formed direction distribution of catoptric light.
[Claim 8]The high-reflective-liquid-crystal display device according to claim 7 which provided two or more crevices.
[Claim 9]The high-reflective-liquid-crystal display device according to claim 7 or 8 which enlarged the area of a flat part compared with area of a crevice.
[Claim 10]The high-reflective-liquid-crystal display device according to any one of claims 7 to 9 which has an inclined plane or a curved surface in a field to which a bottom of a flat part and a crevice is connected.
[Claim 11]The high-reflective-liquid-crystal display device according to claim 10 which made an angle of gradient of an inclined plane of a crevice formed in a reflector 30 degrees or less 10 degrees or more to a reflector substrates face.
[Claim 12]It is the high-reflective-liquid-crystal display panel which allocated a pixel of a large number which display by reflecting outdoor daylight which passed a liquid crystal layer and entered from a counter substrate in the direction of said counter substrate with a reflector board which provided a reflector, A high-reflective-liquid-crystal display panel which provided a portion which has dispersion nature in a reflector to outdoor daylight which entered for every aforementioned pixel, and a portion which has mirror plane nature in a position for every pixel of a reflector.

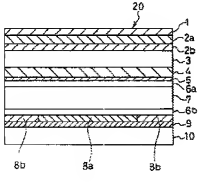
[Translation done.]

１５　　１６

【図７】本発明の実施の形態２の反射型液晶表示素子の構造断面図
【図８】同実施の形態２の反射型液晶表示パネルの上面図
【図９】同実施の形態２の反射型液晶表示パネルのエッチング工程図
【図１０】本発明の実施の形態３の反射型液晶表示素子の構造断面図
【図１１】同実施の形態３の反射型液晶表示パネルの上面図
【図１２】本発明の実施の形態３のホール部分の構造断面図
【図１３】本発明の実施の形態４の反射型液晶表示素子の構造断面図
【図１４】同実施の形態４の反射型液晶表示パネルの上面図
【図１５】従来の反射型液晶表示パネルの構造断面図
【図１６】反射型液晶表示パネルに入射した外光が全反射する条件を示す図
【符号の説明】

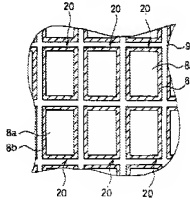
１	偏光フィルム
２ａ、２ｂ	高分子フィルム
３	対向基板
４	カラーフィルタ
５	透明電極
６ａ、６ｂ	配向膜
７	液晶
８ａ	鏡面性の反射電極
８ｂ	散乱性の反射電極
８ｃ	鏡面部分
８ｄ	散乱部分
９	絶縁膜
１０	反射電極基板
１１	ゲート線
１２	ソース線
１３	ＴＦＴ素子
１４	ドレイン電極
１５	平坦化膜
１６	コンタクトホール
１７	ホール
１７ａ	ホールの傾斜面
１７ｂ	ホールの底面
１７ｃ	平坦部
１８	光源
１９	受光器
２０	反射型液晶表示素子
２１	フォトレジスト膜
２２	フォトレジスト膜のない部分
３１	偏光フィルム
３２	高分子フィルム
３３	ガラス基板
３４	カラーフィルタ
３５	透明電極
３６	液晶
３７	散乱反射電極
３８	ガラス基板

【図１】

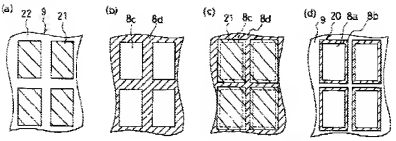


１…偏光フィルム
２ａ、２ｂ…高分子フィルム
３…対向基板
４…カラーフィルタ
５…透明電極
６ａ、６ｂ…配向膜
７…液晶
８ａ…鏡面性の反射電極
８ｂ…散乱性の反射電極
９…絶縁膜
１０…反射電極基板
２０…反射型液晶表示素子

【図２】

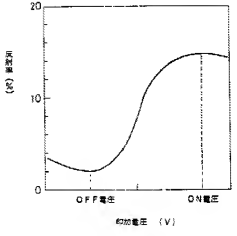


【図3】

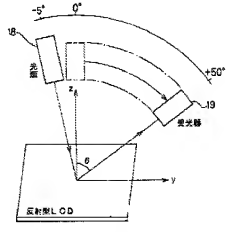


8 c …鏡面部分
8 d …散乱部分
2 1 …フォトレジスト膜
2 2 …フォトレジスト膜のない部分

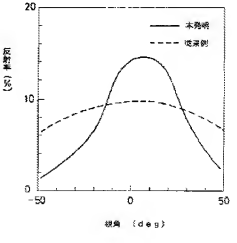
【図4】



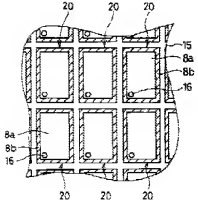
【図5】



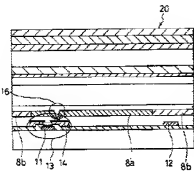
【図6】



【図8】

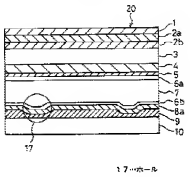


【図7】



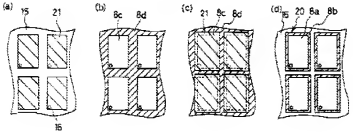
11…ゲート線
12…ソース線
13…TFT素子
14…ドレイン電極
15…平坦化膜
16…コンタクトホール

【図10】

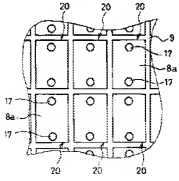


17…ボール

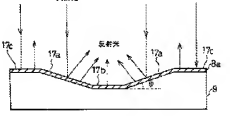
【図9】



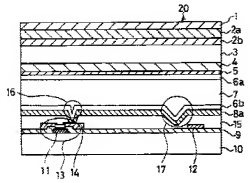
【図11】



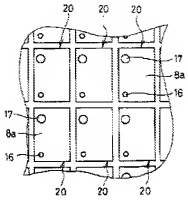
【図12】



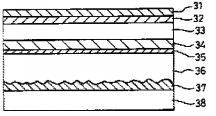
【図13】



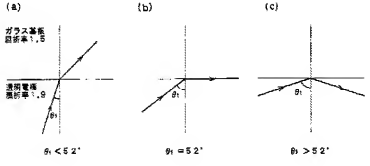
【図14】



【図15】



【図16】



フロントページの続き

(72)発明者　小川　鉄
大阪府門真市大字門真1006番地　松下電器
産業株式会社内